REMARKS/ARGUMENTS

The objections to the abstract and the specification have been addressed in the substitute specification and abstract submitted herewith. Some minor corrections, in addition to those suggested by the Examiner, have been made.

The objections to the claims, and the rejections thereof, have been taken into account in drafting the new claims presented herein.

New independent 33 incorporates the features of original claims 1 and 2, and further specifies that the current through the piezoelectric sensor is mirrored in the oscillator circuit to provide a control signal to the automatic gain control. Support for this latter feature can be found in paragraph 0030.

New dependent claim 34 corresponds to original claim 7, except that it requires the oscillator, and not "all elements in the feedback loop," to operate in a linear mode.

New claim 35 introduces features set out in paragraph 0033, and more specifically defines an amplifier that can act as the current mirror referred in new independent claim 33.

New claims 36, 37 and 39 correspond respectively to previously presented claims 4, 19, and 5.

Claims 38 and 40 introduce to the claims features set out in paragraphs 33 and 32, respectively.

Claim 41 of the enclosed proposed claims corresponds to the original claim 10.

New claims 42, 43 and 44 are new method claims. New claims 45-50 correspond to original claims 13- 18.

Claim 51 is a new claim the support for which is found in the latter part of paragraph 0024. This claim is directed to

apparatus in which the passive elements of the oscillator circuit are entirely resistive to that, in use, the oscillator circuit oscillates at a frequency substantially determined by the piezoelectric sensor alone.

New claim 52 corresponds to original claim 2, new claims 53 - 58 correspond to new claims 36 - 41 respectively, and new claims 59 - 64 correspond to new claims 49 - 50, respectively.

New claims 64-69 are supported in paragraphs 0040 and 0042.

The lack of antecedent basis in original claims 12 and 20, and the problems with claim 12, 21, and 27 do not exist in the claims presently presented.

The "use claims" currently presented now include specific method steps. Claims directed to a "new use of a known. . . machine" are provided for in 35 U.S.C. §§ 100 and 101. It follows, *a fortiori,* that a claim directed to a use of a new machine is proper, provided that it recites a method in sufficiently definite terminology. Although it is true that a method limitation does not limit an apparatus, the converse is not true; a method claim can be limited by apparatus limitations. That is the case here. Measuring viscosity, for example, by a quartz microbalance, is not new, but measuring it using a quartz microbalance having an automatic gain control controlled by mirrored sensor current, or a quartz microbalance in which the oscillator elements are all resistive, is a new process, and there is nothing in section 112 that prohibits reliance on an apparatus limitation in a process claim for patentability.

Turning to the statutory double patenting rejection raised in paragraph 6, the new claims overcome this rejection

since none of the new claims is co-extensive with any claim in U.S. Patent No. 6,647,764. For example in the present application, independent claims 33 and 42 refer to the mirror current, and claim 51 requires the passive elements of the oscillator to be entirely resistive.

The obviousness-type double patenting rejection is addressed by a terminal disclaimer.

Turning to paragraphs 8 - 16 of the Office action, new claim 33 defines features which are neither shown nor suggested in Paul 4,788,466, or otherwise in the cited references, and which give rise to important advantages. In Paul '466, for example, the feedback signal is derived from the voltage detected across resistor 15, not by mirroring the current in the crystal 13. Crystal 13 and resistor 15, in effect, divide the voltage output from amplifier 21, so that the portion of the output voltage appearing across each of these two elements is related to the relative impedance of the elements. Such an arrangement presents no problem if the crystal is only intended to operate over a relatively narrow range of impedance. However, if the crystal has a relatively low impedance, most of the voltage from amplifier 21 will appear across resistor 15, so that the amplifier 21 will not supply a sufficient amount of power to drive crystal 13. If, however, the resistance of the crystal 13 increases significantly, for example, as a result of being placed in a viscous liquid, then most of the voltage will appear across crystal 13, not resistor 15. In that event, there will be insufficient voltage input to amplifier 17 to overcome losses in the feedback loop, and oscillation consequently cannot be maintained in the circuit.

In the circuit according to new claim 33, the feedback signal is derived from a current which mirrors the current in the piezoelectric sensor, i.e., the current is generated by a separate current source (which in the preferred embodiment is internal to the CLC520 integrated circuit). This current is generated without tapping voltage from the crystal drive supply. Consequently, the crystal can be driven through a very low output impedance source, and no voltage division is necessary to provide the feedback signal. Therefore, the current through the crystal is purely determined by the impedance of the crystal and its load. Such a circuit does not have the feedback loss or power delivery problems present with the voltage divider approach used in the prior art, and is able to accommodate a relatively wide range of variations of crystal impedance. This makes the circuit considerably more versatile than the circuit shown in Paul '466.

New independent method claim 42 also includes the step of controlling the drive signal by generating a current that mirrors the current through the piezoelectric sensor and using the mirror current to create an automatic gain control feedback signal. Thus, claim 10 is also novel and non-obvious over Paul.

Turning to claim 51, the oscillator circuit of Paul (figures 1 and 3) includes a phase shifter 19. In order to function as such, the phase shifter must include reactive elements. Thus the passive elements of the oscillator circuit of Paul are not entirely resistive. Indeed, Paul teaches that some reactive elements in the feedback loop are necessary in order to provide a phase shifter in the feedback signal, and

therefore teaches away from having purely resistive passive elements in the feedback loop.

Turning to paragraph 11 of the Office action, in Komplin, the feedback signal from the crystal X1 to the two-stage amplifier (see figure 2) is a voltage divided between the crystal and a resistor R15. In any case, Komplin fails to show an arrangement in which there is a current mirror as now required by the claims 33 and 42. In addition, the oscillator circuit of Komplin includes a tank circuit which includes various reactive passive elements. Thus Komplin also fails to show or suggest the analytical apparatus of claim 51.

Concerning the rejection in paragraph 12 on Rodahl et al. although claims 37 and 54 correspond to claim 19, Rodahl lacks a suggestion of the current mirror feature of claims 33 and 42 and the resistive element requirement of claim 51.

With regard to paragraph 13 of the Office action, the Chagnard et al. paper shows an arrangement in which the oscillator circuit includes a capacitor and an inductor through which the crystal is driven (see figure 2), and therefore does not teach the limitation of claim 19. Chagnard et al. also fail to show a current mirror as required by claims 33 and 42.

Turning to paragraph 14 of the Office action, Hager similarly lacks a teach of the current mirror feature set forth in claims 33 and 42. Hager's FIG. 12 shows an alternative in which a phase shifter is inserted in the feedback loop. However, regardless of whether or not there is a phase shifter in the feedback loop Hager's oscillator circuit also includes reactive elements, e.g. C_p, in the forward circuit of the oscillator. As stated in Hager's

column 12, at lines 15-21, "Capacitors C_1, C_2 (connected to the positive input of amplifier 42) and C_3 are all coupling capacitors, while capacitor C_p is included to allow *the phase shift* of amplifier 42 to be adjusted. . .."

Turning to paragraph 15 of the Office action, Nakamoto et al. show a device in which a crystal is driven by a signal from a voltage controlled oscillator which is fed with a sawtooth wave (page 807). The crystal is therefore driven at a frequency which is swept through a range of frequencies that may include the crystal's resonant frequency. The resonant frequency can be determined by monitoring the impedance of the crystal over the swept frequency range to determine the peak in impedance related to the resonant frequency's being achieved. The circuit described in this paper does not therefore provide an output which oscillates at a frequency substantially determined by the resonant frequency of the crystal, as required by independent claims 33, 42 and 51.

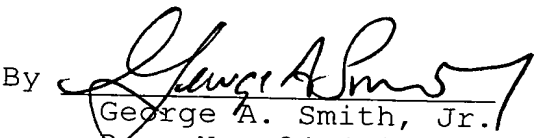
Moreover, the circuit in Nakamoto et al. operates in a quite different way from an oscillator circuit that drives the crystal at resonance, and Nakamoto provides no explicit disclosure of any type of oscillator feedback loop. Thus the circuit does not constitute an oscillator circuit of the kind defined in claims 33 and 51, nor does it disclose the method as set forth in claim 42. There is no suggestion in Nakamoto et al. of an AGC amplifier that derives its control signal from a current mirror.

The rejection in paragraph 16 depends on Paul '466. Even if Paul and Karube were to be combined the result would still

lack the features of the independent apparatus and method claims as presented currently.

In summary, the amended claims now define subject matter that is neither anticipated, nor shown to have been obvious, by the prior art of record. Favorable reconsideration and allowance of the application are requested.

Respectfully submitted,
HOWSON & HOWSON

By 
George A. Smith, Jr.
Reg. No. 24,442
Howson & Howson
Box 457
Spring House, PA 19477
Telephone: 215 540 9200
Facsimile: 215 540 5818

Enclosure:
(a) Request for extension of time
(b) Extension fee
(c) Clean substitute specification
(d) Clean amended abstract
(e) Replacement drawing and annotated drawing
(e) Terminal disclaimer
(f) Terminal disclaimer fee
(g) Fee for additional claims

AMENDMENT TO THE DRAWINGS

Please substitute the attached replacement sheet bearing FIG. 5 for the corresponding original drawing sheet. An annotated sheet showing the changes is also attached. The change is the interchange of the outputs of each of the two buffers. This change brings FIG. 5 into conformity with FIG. 4a, as required by paragraph 0034.

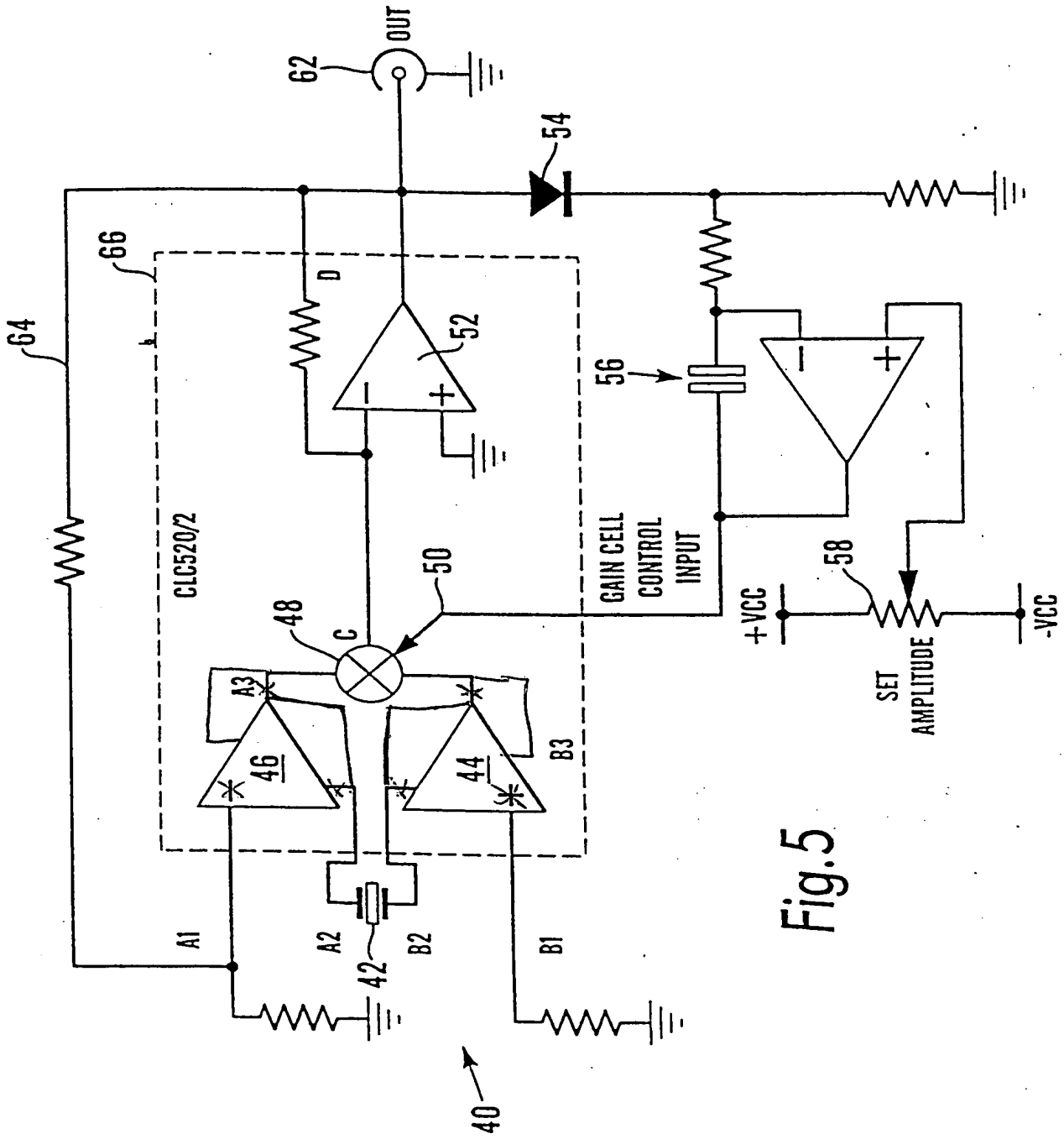


Fig.5